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1. Your reference — P0695

2. Patent application number *(The Patent Office will fill in this part)* — **0200914.0** — 16 JAN 2002

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

Ceramaspeed Limited
Zortech Avenue
Oldington
Kidderminster
Worcestershire DY11 7DY

Patents ADP number *(if you know it)* — 442843900 2

If the applicant is a corporate body, give the country/state of its incorporation — United Kingdom

4. Title of the invention

APPARATUS AND METHOD FOR CONTROLLING AN ELECTRIC HEATING ASSEMBLY

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

DEREK JACKSON ASSOCIATES

The Old Yard, Lower Town
Claines
Worcester WR3 7RY

Patents ADP number *(if you know it)* — 7737554001

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

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Number of earlier application	Date of filing *(day / month / year)*

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Continuation sheets of this form	
Description	14
Claim *(s)*	7
Abstract	1
Drawing *(s)*	3 +3

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Request for substantive examination *(Patents Form 10/77)*	
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11. I/We request the grant of a patent on the basis of this application.

Signature

Date 14 Jan 2002

12. Name and daytime telephone number of person to contact in the United Kingdom — Derek Jackson - Tel : 01905 755180

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DUPLICATE

APPARATUS AND METHOD FOR CONTROLLING AN ELECTRIC HEATING ASSEMBLY

This invention relates to an apparatus and a method for controlling an electric heating assembly in which a radiant electric heater is arranged beneath a glass-ceramic cooking plate in a cooking appliance.

When a radiant electric heater is operating beneath a glass-ceramic cooking plate, in order to heat a cooking vessel located on an upper surface of the cooking plate, the lower surface of the cooking plate is heated by direct radiation from the heater and heat is transferred through the cooking plate to the cooking vessel on the upper surface. In free radiation conditions, that is without any cooking vessel on the cooking plate, the radiant heaters in a glass-ceramic cooktop appliance will transmit heat to a back wall, for example a wall of a kitchen, and to any side wall adjacent to the cooktop. Temperature limits for the back wall and any side walls are specified in European Safety Standard EN60335.

Further, in order to prevent thermal damage occurring to the cooking plate, the temperature, particularly of the lower surface, must be controlled. In order to control the temperature of the lower surface of the glass-ceramic

cooking plate, temperature limiters are provided in heaters to de-energise the heaters at a predetermined temperature. Such limiters, which have generally been of electro-mechanical construction, are set to respond to the temperature of the upper surface of the cooking plate.

As a precaution, in order to meet the various requirements of the glass-ceramic cooktop and appropriate safety standards, the temperature limiter is generally set to switch, in free radiation conditions, at a relatively low temperature of the upper surface (commonly referred to as top glass temperature), which may be less than 550 degrees Celsius. Such an arrangement is unsatisfactory as it means that the rate of heat transfer, particularly to cooking vessels having less than ideal contact with the upper surface of the cooking plate, is reduced by premature switching of the limiter, making it impossible to make maximum and optimum use of the available power of the heaters.

It is an object of the present invention to overcome or minimise this problem.

According to one aspect of the present invention there is provided apparatus for providing electronic control of an

electric heating assembly in which a radiant electric heater is arranged at a lower surface of a glass-ceramic cooking plate, the cooking plate having an upper surface for receiving a cooking vessel, the apparatus comprising: a temperature sensor for monitoring temperature at or adjacent to the cooking plate, which sensor provides an electrical output as a function of temperature; and control means connected to the temperature sensor and to the heater, for controlling energising of the heater from a power supply, the control means being adapted and arranged to energise the heater at a plurality of user selectable power levels including a full power level, wherein when the heater is energised at the full power level it is energised at a first power level during a predetermined initial period and is thereafter energised at a second power level, lower than the first power level.

According to a further aspect of the present invention there is provided a method of providing electronic control of an electric heating assembly in which a radiant electric heater is arranged at a lower surface of a glass-ceramic cooking plate, the cooking plate having an upper surface for receiving a cooking vessel, the method comprising: providing a temperature sensor for monitoring temperature at or adjacent to the cooking

plate, which sensor provides an electrical output as a function of temperature; and providing control means connected to the temperature sensor and to the heater, for controlling energising of the heater from a power supply, the control means being adapted and arranged to energise the heater at a plurality of user selectable power levels including a full power level, wherein when the heater is energised at the full power level it is energised at a first power level during a predetermined initial period and is thereafter energised at a second power level, lower than the first power level.

During an initial minor proportion of the predetermined initial period the heater may be energised at a boost power level, in excess of the first power level.

The predetermined initial period may be from about 20 minutes to about 40 minutes.

The second power level may be between about 60 percent and about 70 percent of the first power level.

The length of the predetermined initial period may be dependent on the time elapsed since the control means was last at full power. The length of the predetermined initial period may be inversely proportional to the time

elapsed since the control means was last at the full power level.

Reduction from the first power level to the second power level may be effected in a continuous or stepwise manner. If stepwise it may be effected in a single step or in a plurality of steps.

The control means may comprise a microprocessor-based controller into which the predetermined initial period and a setting for the second power level are permanently programmed for automatic implementation.

The temperature sensor may provide an electrical output as a function of temperature of the upper surface of the glass-ceramic cooking plate.

The temperature sensor may comprise a device whose electrical resistance changes as a function of temperature and may comprise a platinum resistance temperature detector.

The temperature sensor may be provided on, or spaced behind, the lower surface of the glass-ceramic cooking plate.

The present invention enables full available power of a radiant heater to be applied for the maximum period of time, without the specified limit temperature for EN60335 being exceeded.

The settings for the predetermined initial period and the second power level are determined by experiment during manufacture, for each specific heater assembly, and fixedly programmed into the control means during the manufacturing process.

For a better understanding of the invention and to show more clearly how it may be carried into effect, reference will now be made, by way of example, to the accompanying drawings in which:

Figure 1 is a diagrammatic perspective view showing a glass-ceramic cooktop appliance mounted adjacent to a back wall and a side wall;

Figure 2 is a plan view of an electric heater assembly adapted for control according to the present invention;

Figure 3 is a section along line A-A of the heater of the assembly of Figure 2;

Figure 4 is a graphical illustration of temperature of the upper surface of a cooking plate in the heating assembly of Figures 1 and 2, during control according to the present invention; and

Figure 5 is a graphical illustration of power levels supplied to a heater during operation of the cooking assembly of Figures 1 and 2.

Referring to Figure 1, there is shown a glass-ceramic cooktop appliance 2 mounted on a counter surface 4 adjacent to a back wall 6 and a side wall 8.

Referring to Figures 2 and 3, an electric heater 10 is arranged beneath a glass-ceramic cooking plate 12 in the cooking appliance 2. The heater 10 comprises a metal dish 14 having a base layer 16 of thermal insulation material, such as microporous thermal insulation material. A heating element 18 is supported on the base layer 16. As shown, the heating element 18 comprises a corrugated metal ribbon supported edgewise on the base layer 16. However, the heating element 18 could comprise other forms, such as wire or foil, or one or more infrared lamps. Any of the well-known forms of heating element, or combinations thereof, could be considered.

A peripheral wall 20 of thermal insulation material is provided, a top surface of which contacts a lower surface 22 of the glass-ceramic cooking plate 12.

A temperature sensor 24 is arranged to extend partially across the heater, between the heating element 18 and the cooking plate 12. The temperature sensor 24 comprises a tube containing a device which provides an electrical output as a function of temperature or a beam or other member carrying a device which provides an electrical output as a function of temperature. Such device may have an electrical parameter, such as electrical resistance, which changes as a function of temperature. In particular, the device comprises a platinum resistance temperature detector.

As an alternative to the temperature sensor 24, a temperature sensor could be provided deposited on, or secured in contact with, the lower surface 22 of the cooking plate 12.

A terminal block 26 is arranged at the edge of the heater and by means of which the heating element 18 is electrically connected to a power supply 28 for energising.

Control circuitry 30 is provided for the heater 10. Such control circuitry comprises a microcontroller 32, which is a microprocessor-based control unit. An energy regulator 34 is also provided, which has a control knob 36 by means of which a plurality of user-selectable energy (power level) settings of the heater 10, including a full power setting, can be achieved in known manner.

Power is supplied to the heater 10 from the power supply 28 by way of a relay 38, or by way of a solid state switch means, such as a triac.

The temperature sensor 24 is calibrated in association with the microcontroller 32 to provide an electrical output which is tuned as a function of temperature of an upper surface 40 of the cooking plate 12, which upper surface 40 is arranged to receive a cooking vessel 42.

The temperature of the glass-ceramic cooking plate 12 must not exceed a certain level in order to prevent thermal damage to the glass-ceramic material. For optimum cooking performance, it is required to be able to heat up the cooking vessel 42 and its contents as rapidly as possible, for example to achieve rapid boiling of the contents of the cooking vessel 42. Accordingly, it is desirable for the temperature of the upper surface 40 of

the cooking plate 12, at which the temperature sensor 24 operates for controlling the heater 18, to be as high as permissible. However, this must not be such as to result in an unacceptably high temperature of the cooking plate 12, or an unacceptably high temperature of the back wall a limit for which is specified in European Safety Standard EN60335.

In the present invention it has been found that for a heater 10 operated in a free radiation condition at a full power level setting and controlled by way of the temperature sensor 24, such conditions can be safely maintained at a first power level for a predetermined initial period without the temperature of the back wall 6 and side wall 8 exceeding the specified limit. It has been found that such predetermined initial period is from about 20 to about 40 minutes and is typically about 30 minutes. It has also been found that if, at the end of such predetermined initial period, the power level of the heater 10 is then reduced from the first power level to a second power level which is between about 60 percent and about 70 percent of the first power level, the temperature of the back wall 6 and side wall 8 is maintained at a level which does not exceed the specified limit. The microcontroller 32 is programmed in the factory, during manufacture of the heater 10 and its

associated control circuitry, with the necessary data for the predetermined initial period and the reduced power level. Such programmed data is thereafter automatically implemented by the microcontroller 32 to control the heater 10.

The controlling operation is illustrated in Figure 4, which is a plot of the temperature of the upper surface 40 of the cooking plate 12 (known as the top glass temperature) against time in minutes at the full power setting. During a pre-set initial period A of 30 minutes, the heater 10 is operated at a boost power level for a period B of about 7 minutes, followed by operation at a normal full (first) power level for a further 23 minutes. During the boost period, the temperature of the upper surface 40 of the cooking plate 12 exceeds 600 degrees Celsius and during the remainder of the predetermined initial period the temperature of the upper surface 40 of the cooking plate 12 is maintained at around 600 degrees Celsius. This enables rapid heating to boiling to take place in the cooking vessel 42. However, during this initial period A the temperature of the back wall 6 and side wall 8 does not exceed the limit specified by European Safety Standard EN60335. At the end of the period A, the microcontroller 32 automatically reduces the power level of the heater 10 to a lower

(second) fallback level which is about 60 to 70 percent of the previous full (first) power level. Such reduction, as denoted by reference numeral 44, can be effected in one or more steps, or continuously. During the subsequent ongoing period C, the temperature of the upper surface 40 of the cooking plate 12 is maintained at about 500 degrees Celsius and this ensures that the back wall 6 and side wall 8 are maintained at a temperature which does not exceed the specified limit. However, as shown in Figure 4, the reduced temperature resulting from the reduced power level is not such as to interfere with a temperature band 46, required for frying activities, and a temperature band 48, required for continuous boiling/simmering activities.

During normal operation, the heater 10 may be switched off, or to a lower power level setting, by a user and then back to full power while the temperature of the back wall 6 and side wall 8 is still elevated. In this case the fallback (second) power level requires to be re-introduced in a short time compared with the situation when the heater is first energised. In this case, the time at full (first) power, originally set to full power, may be reduced by an amount inversely proportional to the time interval since the heater was last at full power.

Thus, for example, the time before the heater is operated at the fallback power level may be the initial time (e.g., 30 minutes) less half the time interval since the heater was last at full power. As a practical example, as illustrated in Figure 5, the heater is switched to full power, and reverts to the fallback power level after 30 minutes. The heater is then switched off, or to low power, at 40 minutes and is subsequently switched back to full power at 50 minutes. In this case, the heater remains at full power for (50 - 30)/2 minutes, i.e. 10 minutes, before reverting to the fallback power level.

In more detail, after the heater is switched to full power from cold, for example to boil a pan of water, the power level is set by the control circuitry at the boost power level for a period of 7 minutes to provide accelerated initial heat up. At point D, the power level is reduced to normal full power. At point E, that is after a total of 30 minutes of boost and full power, the power level reverts to the fallback power level. At this power level, the heat output is such that the temperature of the back wall 6 and the side wall 8 will not exceed the maximum specified by EN60335, but at the same time is sufficient to maintain a significant volume of water at a fast boil or to fry. At point F, after 40 minutes of cooking the user either switches the heater off or to a

lower power setting. At point G, 20 minutes after the heater was last at full power level, the user switches the heater back to full power. The control circuitry maintains the full power level for half of twenty minutes, i.e. for 10 minutes, and at point H, after 10 minutes at full power, the power level reverts to the fallback power level.

In practice, the manner in which the time before the heater reverts to fallback power level is determined may be established from experimental data and could be other than a simple inverse proportionality.

CLAIMS

1. Apparatus for providing electronic control of an electric heating assembly in which a radiant electric heater is arranged at a lower surface of a glass-ceramic cooking plate, the cooking plate having an upper surface for receiving a cooking vessel, the apparatus comprising: a temperature sensor for monitoring temperature at or adjacent to the cooking plate, which sensor provides an electrical output as a function of temperature; and control means connected to the temperature sensor and to the heater, for controlling energising of the heater from a power supply, the control means being adapted and arranged to energise the heater at a plurality of user selectable power levels including a full power level, wherein when the heater is energised at the full power level it is energised at a first power level during a predetermined initial period and is thereafter energised at a second power level, lower than the first power level.

2. Apparatus as claimed in claim 1, wherein during an initial minor proportion of the predetermined initial period the heater is energised at a boost power level, in excess of the first power level.

3. Apparatus as claimed in claim 1 or 2, wherein the predetermined initial period is from about 20 minutes to about 40 minutes.

4. Apparatus as claimed in any preceding claim, wherein the second power level is between about 60 percent and about 70 percent of the first power level.

5. Apparatus as claimed in any preceding claim, wherein the length of the predetermined initial period is dependent on the time elapsed since the control means was last at the full power level.

6. Apparatus as claimed in claim 5, wherein the length of the predetermined initial period is inversely proportional to the time elapsed since the control means was last at the full power level.

7. Apparatus as claimed in any preceding claim, wherein reduction from the first power level to the second power level is effected in a continuous manner.

8. Apparatus as claimed in any one of claims 1 to 6, wherein reduction from the first power level to the second power level is effected in a stepwise manner.

9. Apparatus as claimed in claim 8, wherein reduction from the first power level to the second power level is effected in a single step.

10. Apparatus as claimed in claim 8, wherein reduction from the first power level to the second power level is effected in a plurality of steps.

11. Apparatus as claimed in any preceding claim, wherein the control means comprises a microprocessor-based controller into which the predetermined initial period and a setting for the second power level are permanently programmed for automatic implementation.

12. Apparatus as claimed in any preceding claim, wherein the temperature sensor provides an electrical output as a function of temperature of the upper surface of the glass-ceramic cooking plate.

13. Apparatus as claimed in any preceding claim, wherein the temperature sensor comprises a device whose electrical resistance changes as a function of temperature.

14. Apparatus as claimed in claim 13, wherein the temperature sensor comprises a platinum resistance temperature detector.

15. Apparatus as claimed in any preceding claim, wherein the temperature sensor is provided on, or spaced behind, the lower surface of the glass-ceramic cooking plate.

16. Apparatus for providing electronic control of an electric heating assembly substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

17. A method of providing electronic control of an electric heating assembly in which a radiant electric heater is arranged at a lower surface of a glass-ceramic cooking plate, the cooking plate having an upper surface for receiving a cooking vessel, the method comprising: providing a temperature sensor for monitoring temperature at or adjacent to the cooking plate, which sensor provides an electrical output as a function of temperature; and providing control means connected to the temperature sensor and to the heater, for controlling energising of the heater from a power supply, the control means being adapted and arranged to energise the heater at a plurality of user selectable power levels including

a full power level, wherein when the heater is energised at the full power level it is energised at a first power level during a predetermined initial period and is thereafter energised at a second power level, lower than the first power level.

18. A method as claimed in claim 17, wherein during an initial minor proportion of the predetermined initial period the heater is energised at a boost power level, in excess of the first power level.

19. A method as claimed in claim 17 or 18, wherein the predetermined initial period is from about 20 minutes to about 40 minutes.

20. A method as claimed in any one of claims 17 to 19, wherein the second power level is between about 60 percent and about 70 percent of the first power level.

21. A method as claimed in any one of claims 17 to 20, wherein the length of the predetermined initial period is dependent on the time elapsed since the control means was last at the full power level.

22. A method as claimed in claim 21, wherein the length of the predetermined initial period is inversely

proportional to the time elapsed since the control means was last at the full power level.

23. A method as claimed in any one of claims 17 to 22, wherein reduction from the first power level to the second power level is effected in a continuous manner.

24. A method as claimed in any one of claims 17 to 22, wherein reduction from the first power level to the second power level is effected in a stepwise manner.

25. A method as claimed in claim 24, wherein reduction from the first power level to the second power level is effected in a single step.

26. A method as claimed in claim 24, wherein reduction from the first power level to the second power level is effected in a plurality of steps.

27. A method as claimed in any one of claims 17 to 26, wherein the control means comprises a microprocessor-based controller into which the predetermined initial period and a setting for the second power level are programmed for automatic implementation.

28. A method as claimed in any one of claims 17 to 27, wherein the temperature sensor provides an electrical output as a function of temperature of the upper surface of the glass-ceramic cooking plate.

29. A method as claimed in any one of claims 17 to 28, wherein the temperature sensor comprises a device whose electrical resistance changes as a function of temperature.

30. A method as claimed in claim 29, wherein the temperature sensor comprises a platinum resistance temperature detector.

31. A method as claimed in any one of claims 17 to 30, wherein the temperature sensor is provided on, or spaced behind, the lower surface of the glass-ceramic cooking plate.

32. A method of providing electronic control of an electric heating assembly substantially as hereinbefore described with reference to, and as shown in, the accompanying drawings.

33. An electric heating assembly whenever controlled by the method of any of claims 17 to 32.

ABSTRACT

APPARATUS AND METHOD FOR CONTROLLING AN ELECTRIC HEATING ASSEMBLY

In apparatus and a method for providing electronic control of an electric heating assembly, a radiant electric heater (10) is arranged at a lower surface (22) of a glass-ceramic cooking plate (12), the plate (12) having an upper surface (40) for receiving a cooking vessel (42). A temperature sensor (24) monitors temperature at or adjacent to the cooking plate (12) and provides an electrical output as a function of temperature. Control means (30) connected to the temperature sensor (24) and to the heater (10) controls energising of the heater from a power supply (28) for energising the heater at a plurality of user selectable power levels including a full power level. When the heater (10) is energised at the full power level it is energised at a first power level during a predetermined initial period (A) and is thereafter (C) energised at a second power level, lower than the first power level.

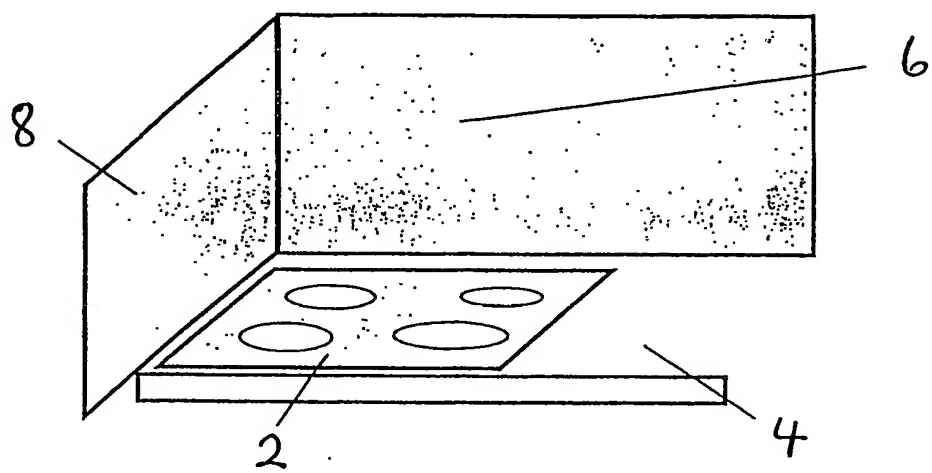
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FIG. 1

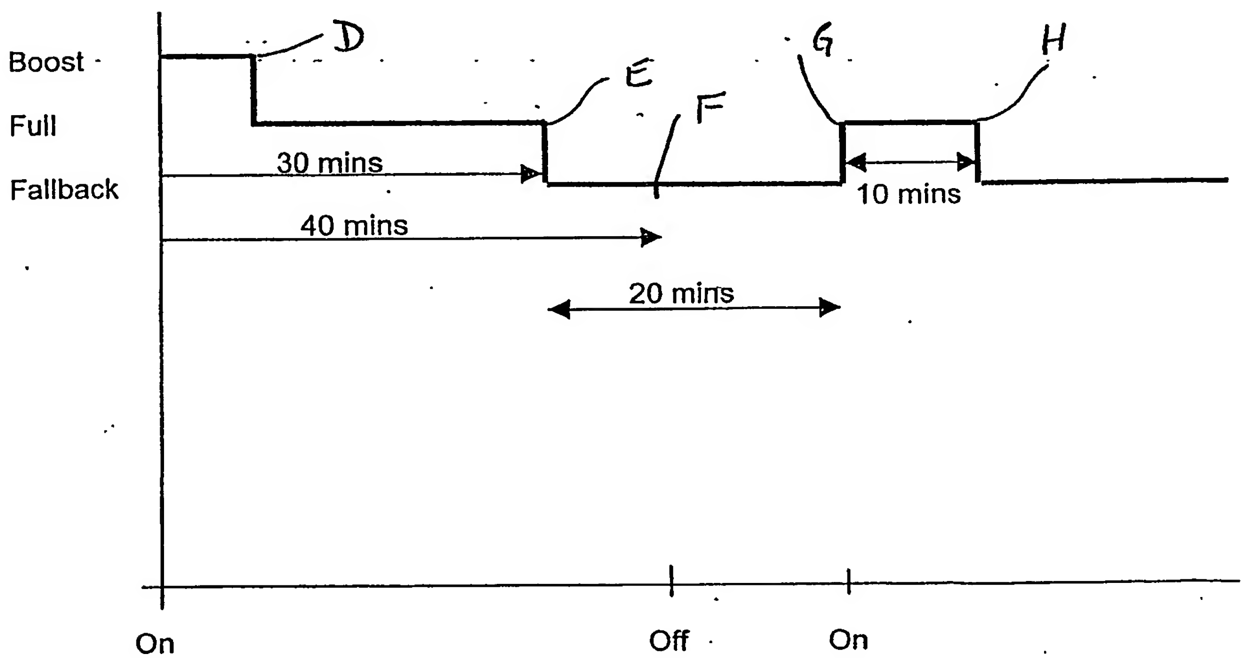
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FIG. 5

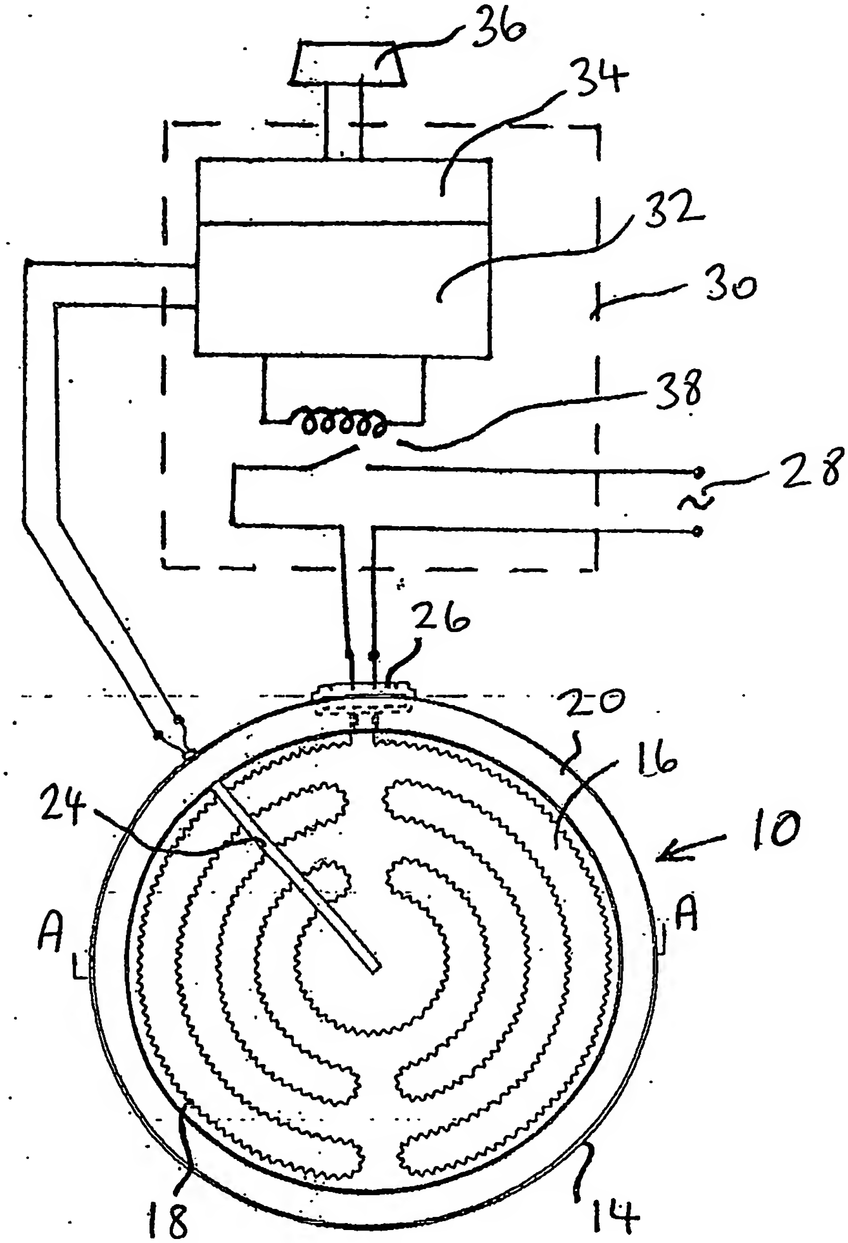

FIG. 2

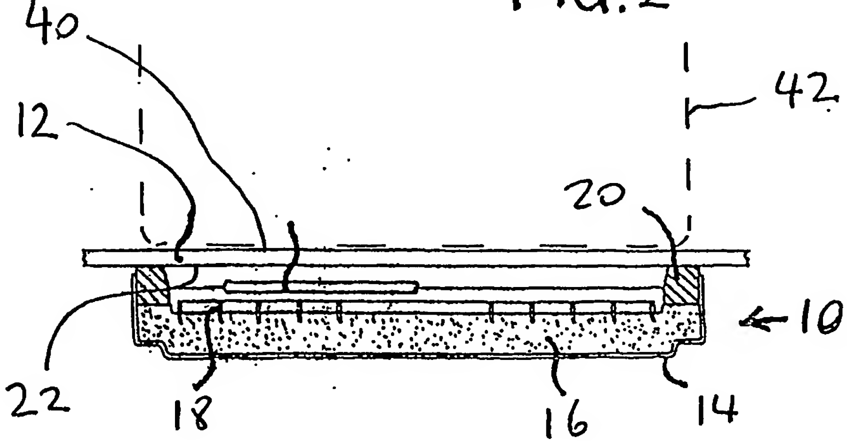

FIG. 3

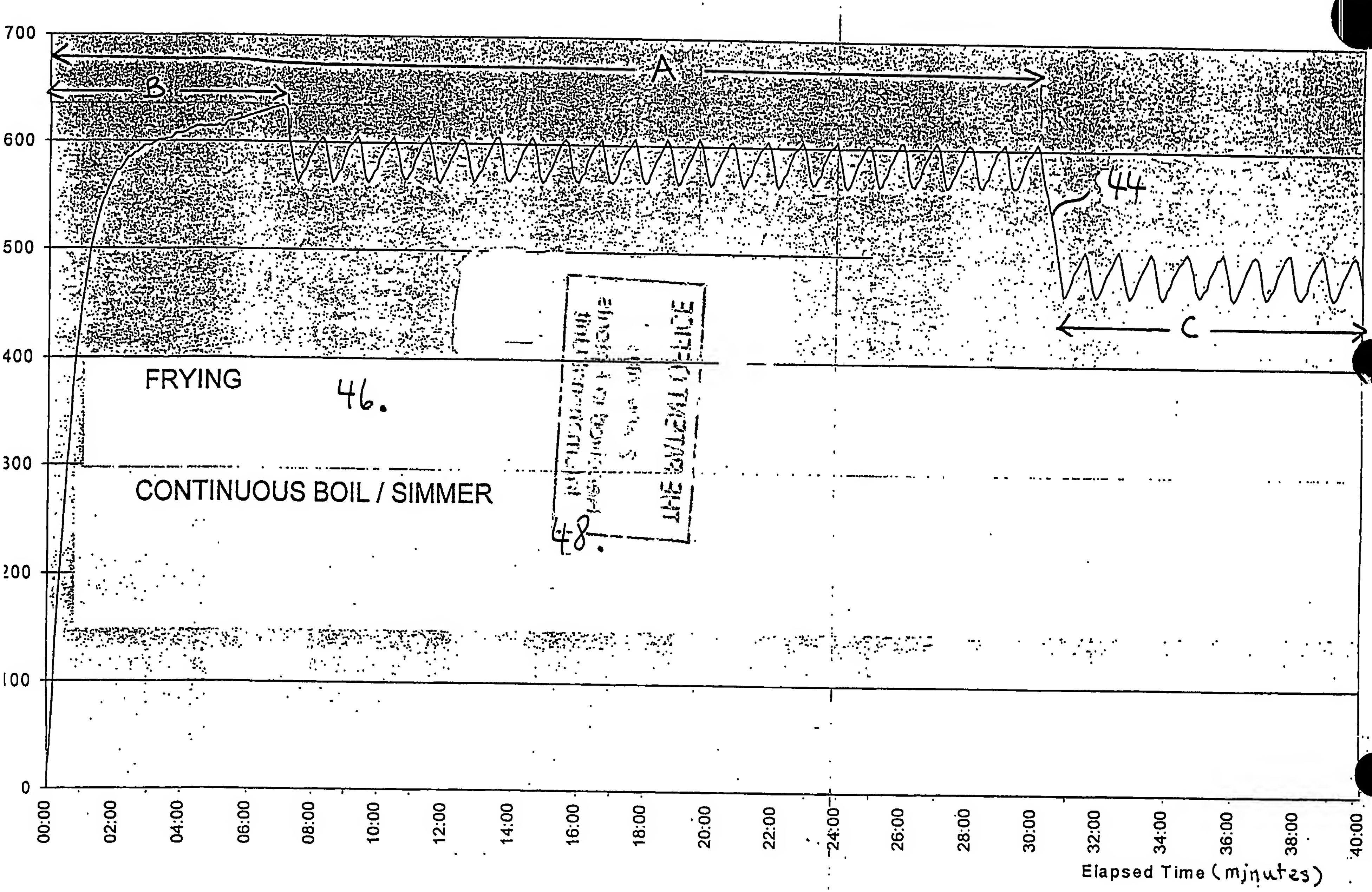
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FIG. 4